"Rotor-grinding machine comprising a rotary head with two grinding wheels"

DESCRIPTION

The present invention is related to grinding machines for turbine or impeller blades or similar.

Previous state of the technique

The problem the present invention solves is the building of a grinding machine with a rotary head and two grinding wheels for grinding, controlling the grinding operations of the blade tips of a rotor, and the shape of the grinding wheel for grinding at the same time during the grinding cycle of a rotor period, by means of a control unit for the positioning of the grinding wheels and the shaping devices, and an optical sensor to measure the blade radius.

From publication US-A-5704826, a turbine rotor blade grinding machine is known where the head is foreseen of two grinding wheels with different features for grinding different rotors in view of the blade legation and width, which avoids the substitution of a grinding wheel and having to repeat the adjusting process of the angular and linear position of the head of the new grinding wheel respect to the new rotor, in the way it is necessary with the machines having a head with an only grinding wheel. In the grinding machine described in publication US-A-5704826, the angular and lineal displacements of the head to position the second grinding wheel are controlled by a control unit of the machine foreseen of a CNC, which calculates the coordinates of the new position starting from geometric data relative to the two grinding wheels,

with the cooperation of an optical measuring system to line up the grinding wheel and measure the radius of the blade tips.

An example of an optical system to line up the grinding wheel and measure the blade radius during the grinding operation at high speed of the rotor, controlled by means of stroboscope between 1500 r.p.m. and 3000 r.p.m. is made to know in publication US-A-4566225, being the light intensity received at the sensor representative of the height or radius of the blades, but here the optical sensor uses an infrared light beam.

To obtain the wished shape bend at the blade tips, the grinding wheel carries out micrometric incremental displacements of the grinding wheel head in both directions, axial and radial, respect to the rotor during the grinding operation. The abrasion due to the use of the grinding wheel for grinding obliges to compensate for the wear and to correct the irregularities of its surface by means of a shaping device for the grinding wheel. The superficial irregularities of the grinding wheel provoke the appearance of burrs at the blade tips, which affect the radius measuring of the blades, and even originating an excess of grinding. A machine, known as the one disclosed in publication EP-0592112-A, has a shaping device foreseen of a diamond roller, supported on a carriage. This known machine has the inconveniences that the shaping device is separated from the grinding wheel head and situated behind it, and the shaping of the grinding wheel is executed once finished the grinding cycle of a rotor period, or also at the interval of a grinding cycle, stopping the grinding operation to separate the head from its working position and taking the grinding wheel till the roller. After the shaping,

the known machine has to place the grinding wheel well adjusted again, in touch with the blade tips to continue the grinding cycle.

Exposition of the invention

The object of the present invention is a grinding machine for compressor or turbine rotor blades, which includes a head with two different grinding wheels, whose positioning is directed by an electronic control unit of the machine, in cooperation with an optical system to measure the radius of the blades during the grinding operation, and a shaping device of the associated grinding wheel to the grinding wheel head, which can be activated automatically, in addition to previously fixed moments of the grinding cycle, during the grinding period in answer to an indication of the measuring signal generated by the optical system.

The electronic control unit, in addition to the angular and linear displacements of the grinding wheel head during the grinding, controls the positioning of one or the other grinding wheel on each rotor period, by means of the calculation based on the dimensions and geometric distances of both grinding wheels. The optical system to measure the blade radius is able to detect in a continuous way the presence of burrs on the blade tips, and the control unit activates the shaping device of the grinding wheel automatically during the grinding cycle, without altering the position of the grinding wheel and its rotation, and without it being necessary for an operator to be present. The shaping device is moved putting the shaping roller in touch with the grinding wheel. This way the grinding cycle is not interrupted, stopping only the forward movement of the grinding wheel.

Description of the drawings

Figure 1 is a top view of a grinding machine for a compressor rotor, showing the grinding of a rotor period.

Figure 2 is a raised view of the grinding machine of figure 1.

Detailed description of the preferred realization

With reference to figures 1 - 2, a preferred realization of a grinding machine 1 for the blades for a turbine or a compressor rotor 2 according to the invention includes:

- a machine bench 3,
- a carriage 4 supporting two pedestals 5 supporting the rotor 2 movable in an axial direction Z of the rotor 2,
- a grinding wheel head 6 foreseen of two grinding wheels for grinding 7, 7' with different features,
- a carriage 8 of the head to rotate the head 6 in an angular movement B around a central vertical shaft 6a, and two carriages 9, 10 of the head to move it in a linear movement to position it in the mentioned direction Z and a forward displacement of the grinding wheel in a radial direction X of the rotor 2,
- a respective shaping device 12, 13 for each grinding wheel 7, 7' supported on an individual carriage 14, 15 associated to the grinding wheel head,
- an electronic control unit 16 including a numerical control CNC to calculate and control the movements of the mentioned carriage, and
- a system 16 - 24 to measure the radius R of the blades, including an optical sensor 19 lined up according to the shaft with reference 11 (figure 1) with the rotor period 2a of the grinding wheel 7 which is working, and a

measuring instrument, such as a PC computer, which transmits a signal 21, representative of the lining up of the grinding wheel 7 or of the grinding wheel 7' and of the measure obtained of the radius R to the control unit 16.

The carriage 8 of the head gives the head 6 a rotation up to 180 around a central vertical shaft 6a, for the commutation of a grinding wheel 7 (figures 1 and 2) to a second grinding wheel 7' selected for the grinding of a second rotor 2, different from the previously rectified one. An angular displacement B of the carriage is carried out for its relative inclination to the radius R of the blades, depending of the shape bend of the blade tips 25 that are being rectified. For the positioning of the mentioned second grinding wheel 7' faced in touch with the blade tips 25 of a second rotor 2, the carriage 9, 10 offer the head 6 the linear displacements in the directions Z and X, apart from the incremental movement and forward "W" displacements of the grinding wheel during the grinding. The calculation of the position of the second grinding wheel 7' is carried out by the numerical control CNC in function of the diameters D1 and D2 of the two grinding wheels 7, 7' and of the diagonal distance 30 between the surfaces of both grinding wheels 7, 7' (figure 1).

The shaping device 12 - 15 includes a respective carriage 14, 15 supporting a diamond roller 12, 13, the carriage 14, 15 are incorporated on to the grinding wheel head 6 to accompany a respective grinding wheel 7, 7' in its linear displacements X, Z and angular displacement B. The carriage 14, 15 are projected above the head 6, and are moved vertically with its roller 12, 13 for the shaping of its corresponding grinding wheel 7, 7'

carrying out respectively a linear approaching displacement "U" or "C" from a retracted position above the grinding wheel 7 and forward movement of the roller 12, 13 during the shaping. The carriage 14, 15 are foreseen of a screw 14', 15' for its linear displacement governed by the control unit 16, carrying out the shaping without the grinding wheel 7, 7' having to be withdrawn from its contact position with the rotor period 2a that is being rectified.

In a realization example of the grinding machine 1, the optical sensor 19 includes a light source 26 which issues a colimated beam 28 and an electronic photo-detector 27, situated on both opposed arms 19a, 19b of a support in the shape of an arch (figure 2) with greater dimension than the circle of the rotor periods 2a. The opposed arms 19a, 19b of the sensor are situated including the rotor period 2a that is being rectified. Therefore the optical sensor 19 is supported on a carriage 18, which can be moved in the axial direction "Z" to move the sensor 19 from one rotor period 2a to another, and in a direction "Y" to carry out a radial forward movement towards the rotor blades 2a. The colimated beam 28 completely illuminates the blades which during their rotation pass between the source 26 and the photo-detector 27 receiving the latter an image of successive light and dark points corresponding to the light intensity corresponding to the crossing of each blade 25 with the beam 28. The PC computer receives an undulating electric signal 21 (not represented on the drawings) in each revolution, which is representative for the absolute value of the radius R. The signal 21 is not affected by the height of the blades interposed at the beam 28. The PC computer acquires and processes the signal 21 and combines it with a signal 24 of the

rotation speed of the rotor 2 proceeding from an "encoder" 17 of the rotor shaft, and the resulting signal 22 is connected to a control unit 16, to control the grinding and the shaping. The alterations with respect to the values of the undulating signal 21 provoked by the burrs on the blades are detected by the control unit 16 at each moment of the grinding cycle, actuating the device 12 - 15 of the corresponding shaping automatically.